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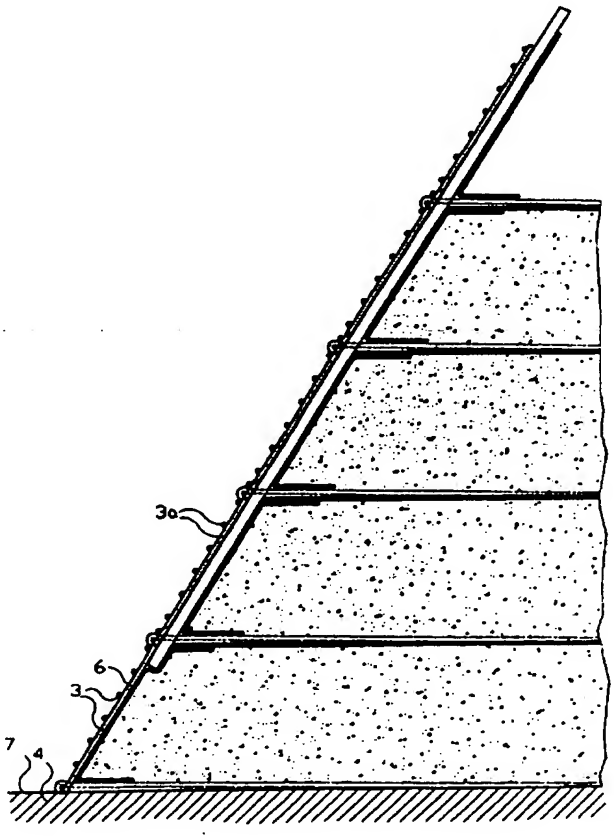
(54) Title: A METHOD FOR ERECTING A REINFORCED SLOPE OF EARTH

(57) Abstract

In a method for building up a reinforced slope of earth, a reinforcing arrangement consists of joined, longitudinal reinforcing mats (3, 3a) at the outside of the slope of earth, longitudinal edges of the reinforcing mats being attached to one end of a row of horizontal tension struts (4, 4a) extending perpendicular to the reinforcing mats (3, 3a), the other end thereof being fastened e.g. by means of plugs (5, 5a) within the earth (7, 8). Along each of the rows of tension struts (4, 4a), a longitudinal, horizontally positioned earth reinforcing mat (9) has been placed. At the inner side of the reinforcing mats (3, 3a), growth mats (6, 6a) have been fixed. A row of preferably about 2.5 meter long guide rods (1) with a spacing of preferably about 1 meter is, during the erection of the slope of earth, positioned forming an inclined plane corresponding to the finished slope of earth. The guide rods (1) are pulled successively upwardly during the erection of the slope of earth and are, finally, removed.



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A METHOD FOR ERECTING A REINFORCED SLOPE OF EARTH

This invention relates to a method for erecting a reinforced slope of earth, wherein the slope of earth is built up layer on layer by means of a plurality of horizontal rows of reinforcing mats forming the inclined front of the slope of earth and being anchored by means of substantially horizontally extending tension struts which become situated within the slope of earth, and wherein each row of reinforcing mats preferably is assigned a growth mat, and wherein, possibly, along each of the rows of substantially horizontally extending tension struts, possibly except the lowermost and uppermost rows of substantially horizontally extending tension struts, is placed a substantially horizontally extending earth reinforcing mat which becomes situated within the slope of earth, and wherein, between the individual layers of the slope of earth having a height substantially corresponding to the vertical extent of the front reinforcing mats, earth mass is filled against and stamped at the inner side of the respective reinforcing mat row.

Reinforced slopes of earth are previously known and form an alternative to supporting walls of concrete or stone.

From French patent No. 2,303,121 it is known a vertical and stepwise shaped grid wall having curve-shaped supporting grids disposed one above the other.

Likewise, from Swiss patent No. 666,510, a grid wall is known, the grid being bent horizontally inwardly into the ground, thus forming an L. The angle between the grid in front and the part of the grid being bent horizontally inwardly into the ground, is fixed through inclined hoops.

The disadvantage of both the above-mentioned grid structures are that they are voluminous and easily get damaged during transport. Also, practice has shown that structures having hoops extending inclinedly inwards into the ground, make it difficult to fill earth mass against the mats and compress the same.

Besides, the state of the prior art is represented through NO generally available patent application No. 910234, GB patent application No. 2,212,532, as well as European patent applications Nos. 197,000 and 574,233.

Thus, EP 574,233 deals with horizontal tension struts which, at one end thereof, are attached to the fore edge of reinforcing mats, and the other end thereof extends into the earth mass as an anchor, and comprising both reinforcing mats and growth mats.

GB 2,212,532 deals with an earth anchorage in the form of horizontal struts in connection with reinforcing mats.

NO 910234 and EP 197,000 deal with a combination of reinforcing mats and growth mats.

The object of the invention is to provide a method for building up a reinforced slope of earth of the kind defined in the introduction, in which the same slope in the vertical direction can be established and maintained for the front side (outer face) of the slope of earth, and wherein, especially, conditions have been arranged and adjusted so as to secure appropriate erecting of the slope of earth, layer on layer, suitably reinforcing the same simultaneously,

and wherein simple and cheap means are required for carrying out the method, said means consisting of parts being light in weight and easy to put together and which are suitable for use in combination with earth mass.

Besides, the method should enable a simple mechanical filling in operation displacing earth mass against the mats as well as effecting a compression of said earth mass as layer after layer of the slope of earth is brought into place.

The objects are achieved through features as defined in the following claims.

An examplary embodiment of a reinforcing arrangement for carrying out a method for building up a reinforced slope of earth in accordance with the invention is described below, reference being made to the attached drawings, wherein:

Figure 1 shows a cross-section, 90° in relation to the front of the slope of earth, showing a first phase of the erection of the reinforced slope of earth;

Figure 2 shows a corresponding cross-section of a second phase of the erection of the reinforced slope of earth;

Figure 3 shows a corresponding cross-section of a later phase of the erection of the reinforced slope of earth;

Figure 4 shows, on a smaller scale, a corrsponding cross-section of the last phase of the erection of the reinforced slope of earth;

Figure 5 shows the same as figure 1, but seen in the direction of the arrow in figure 1.

In the drawings, reference numeral 1 denotes a guide rod, preferably consisting of a square pipe in steel or aluminium.

First phase of the erection of a reinforced slope of earth in accordance with the invention consists in erecting a row of guide rods 1 having a length of e.g. about 2.50 meter, e.g. with a mutual distance of one meter, sloping in an inclined plane corresponding to the front of the finished slope of earth. The guide rods are fixed in this inclined position e.g. by means of temporary inclined guy ropes 2 in front of the guide rods 1, i.e. at the opposite side of the earth side, and in that the guide rods, additionally, are forced a short distance into the earth or fixed in some other way, e.g. by driving a plug down into the ground at the fore side of each guide rod 1.

When the guide rods 1 are positioned, first row 3 of reinforcing mats are positioned lowermost on the guide rods 1, the guide rods 1 being attached temporarily and slidably to the uppermost longitudinal edge of first row 3 of reinforcing mats. Thereafter, the one end of a number of horizontal tension struts 4 are fastened in a mutual distance to the lowermost longitudinal edge of first row 3 of reinforcing mats, the other end of the tension struts 4 being plugged into the ground at the inner side of the guide rods 1 by means of a plug 5, or the tension struts 4 are fixed to the ground in another way. The tension struts 4 may have a length of e.g. 2 meters.

The last step of the first phase consists in that a first open growth cloth or growth mat 6 is fastened at the inner side of first row 3 of reinforcing mats in order to prevent that subsequently filled in earth at the inner side of the guide rods and the reinforcing mats 3 shall penetrate through the openings of the reinforcing mats 3. A distance along the lower edge of first growth mat 6 is bent inwardly along the ground 7.

On figure 2, wherein completed second phase of erection of the reinforced slope of earth is shown, earth 8 is firstly filled in against the first row of reinforcing mats 3 and

thereafter stamped there; a portion along the upper edge of first growth mat 6 is bent inwardly on top of a first earth layer 8; a second row 3a of reinforcing mats are fastened temporarily to the guide rods 1 in the same manner as first row 3 of reinforcing mats; moreover, the uppermost part of first row 3 of reinforcing mats overlaps the lowermost row 3a of reinforcing mats; horizontal tension struts 4a are, at one end thereof, attached to the upper overlapping edge of first row 3 of reinforcing mats, the other end of the tension struts 4a being plugged firmly into first earth layer 8 by means of plugs 5a, or being fixed to the earth layer in some other way; a horizontal earth reinforcing mat 9, preferably of plastic, is placed on top of the earth layer 8; another open growth mat 6a is fastened to the inner side of second row 3a of reinforcing mats; a portion of second growth mat 6a being lowermost bent inwardly on top of first earth layer 8.

Third and fourth phases are carried out exactly in the same way as second phase.

First step in fifth phase, shown completed in figure 3, of erecting the reinforced slope of earth consists in removing the guy ropes 2 and in pulling the guide rods 1 upwardly from the starting position to the position shown in figure 3. Besides, fifth phase is carried out exactly in the same manner as second, third and fourth phases.

Ninth and in this case the last phase, shown completed in figure 4, is carried out exactly in the same manner as the fifth phase, except that no guy ropes 2 have to be removed, and except that no horizontal earth reinforcing mat is placed on top of the completed slope of earth, but with the addition of a last step consisting in removal of the guide rods 1.

It will, without any fuss, be appreciated that reinforced slopes of earth having different height might be erected according to the invention using more or less phases than shown and explained in connection with the examplary embodiment.

For tall slopes, the guide rods 1 are pulled stepwise upwardly as shown in figures 3 and 4.

The thickness of the earth layers associated with the various phases of the erection of the reinforced slope of earth is the same and may suitably be about 50 cm.

C l a i m s

1. A method for erecting a reinforced slope of earth, wherein the slope of earth is built up layer on layer by means of a plurality of horizontal rows of reinforcing mats (3, 3a) forming the inclined front of the slope of earth and being anchored by means of substantially horizontally extending tension struts (4, 4a) which become positioned within the slope of earth, and wherein each row of reinforcing mats (3, 3a) preferably is assigned a growth mat (6, 6a), and wherein, possibly, along each of the rows of substantially horizontally extending tension struts (4, 4a), possibly except lowermost and uppermost rows of substantially horizontally extending tension struts, a substantially horizontally extending earth reinforcing mat (9) is placed, said earth reinforcing mat (9) becoming situated within the slope of earth, and whererin, between the individual earth slope layers which in height substantially correspond to the height extent of the front reinforcing mats (3, 3a), filling in and stamping of earth layers (8) are effected at the inner side of the respective reinforcing mat row (3, 3a), c h a r a c t e r i z e d b y the steps of

a) that a row of guide rods (1), preferably about 2.5 meters long, are erected, e.g. with a spacing of preferably 1 meter in the longitudinal direction of the slope of earth to be erected, so that the guide rods (1) together form an inclined plane corresponding to the front of the slope of earth to be erected, the guide rods (1) being fixed in this inclined position, e.g. by means of temporary guy ropes (2) in front of the guide rods (1) which, additionally, possibly are secured by being driven a small distance into the ground, so that the guide rods (1) upon need easily may be pulled up when the inclined guy ropes (2) or other fixing means have been removed;

b) that the first row of reinforcing mats (3) are placed lowermost on the guide rods (1), and that the guide rods (1)

are attached temporarily and slidably in the longitudinal direction thereof to first reinforcing mat row (3);

c) that the second reinforcing mat row (3a) is placed on the guide rods (1) above first row (3) of reinfrocing mats, and that each of the guide rods (1) is attached temporatily to second row (3a) - or a row situated thereabove - of reinforcing mats in the same way as the attachment to first row (3) of reinforcing mats;

d) that the guide rods (1) are pulled successively upwardly while they at any time take the inclined lower starting position thereof, so that the guide rods (1) at any level support from about 1.5 to about 2.0 meter of the slope of earth;

e) that one, thereafter, continues with third row of reinforcing mats and so forth, besides in accordance with steps c) and d), until the reinforced slope of earth has reached the desired tallness, whereafter the guide rods (1) are removed as they are not to be included in the reinforcement, the guide rods (1) merely having a guiding (in relation to the front angle of the slope of earth) and supporting function.

2. A method as set forth in claim 1, c h a r a c t e r i z e d i n that a portion along an upper edge of each growth mat (6, 6a) attached to the inner side of the associated, externally positioned front reinforcing mat (3, 3a), is bent inwardly on top of the recently placed earth layer (8), so that said growth mat portion becomes anchored between said earth layer (8) and an earth layer thereabove.

3. A method as set forth in claim 1 or 2, c h a r a c t e r i z e d i n that second, third, etc. row of reinforcing mats (3a) is positioned on the inclined guide rods (1) above the underlying reinforcing mat row

(3) in such a manner that an uppermost portion of an underlying row (3) of reinforcing mats overlaps a lowermost portion of the overlying row (3a) of reinforcing mats.

4. A method as set forth in claim 3, c h a r a c t e r i z e d i n that the front end of the substantially horizontally extending tension struts (4a) is attached to the upper overlapping edge portion of an underlying row (3) of reinforcing mats.

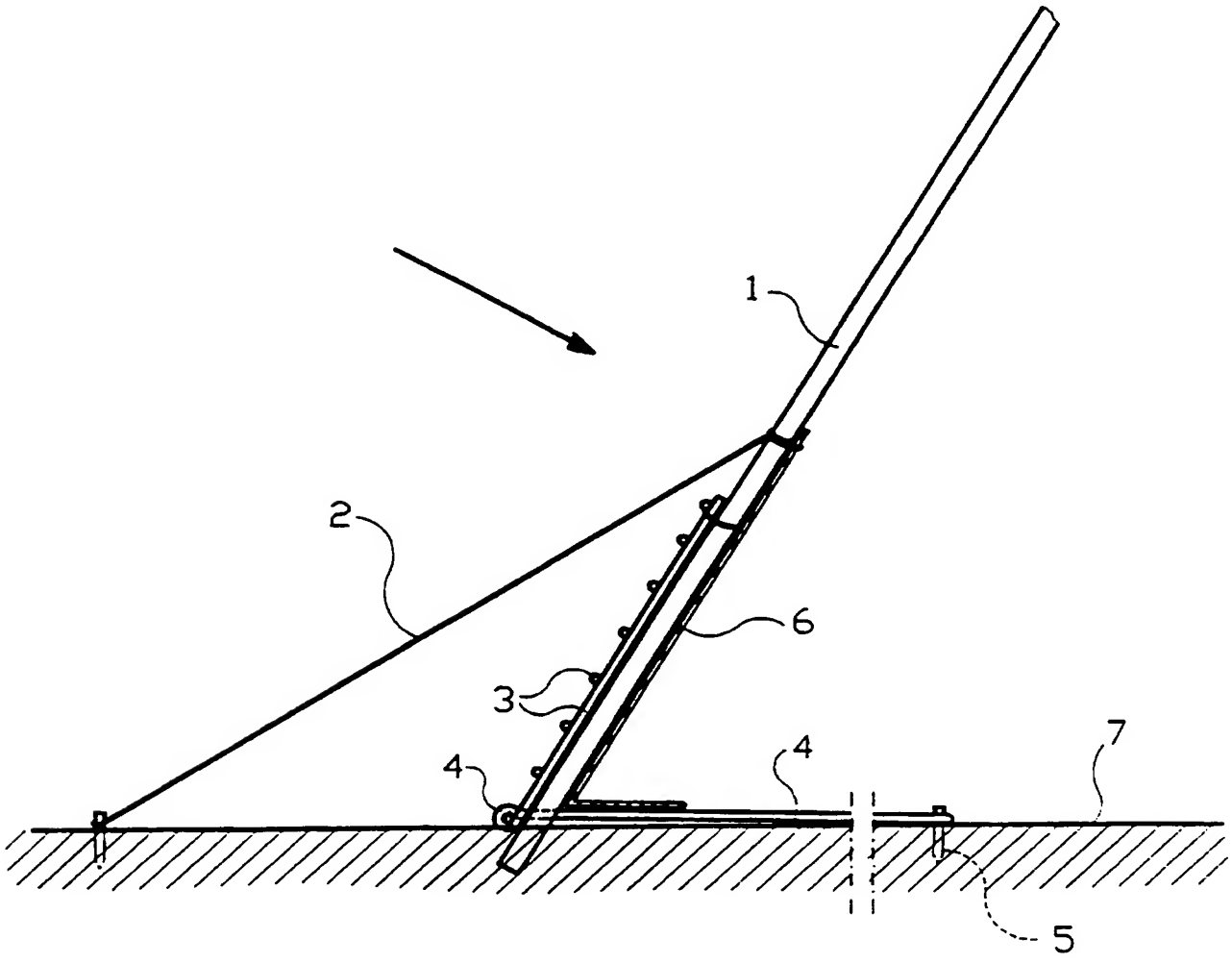


Fig. 1

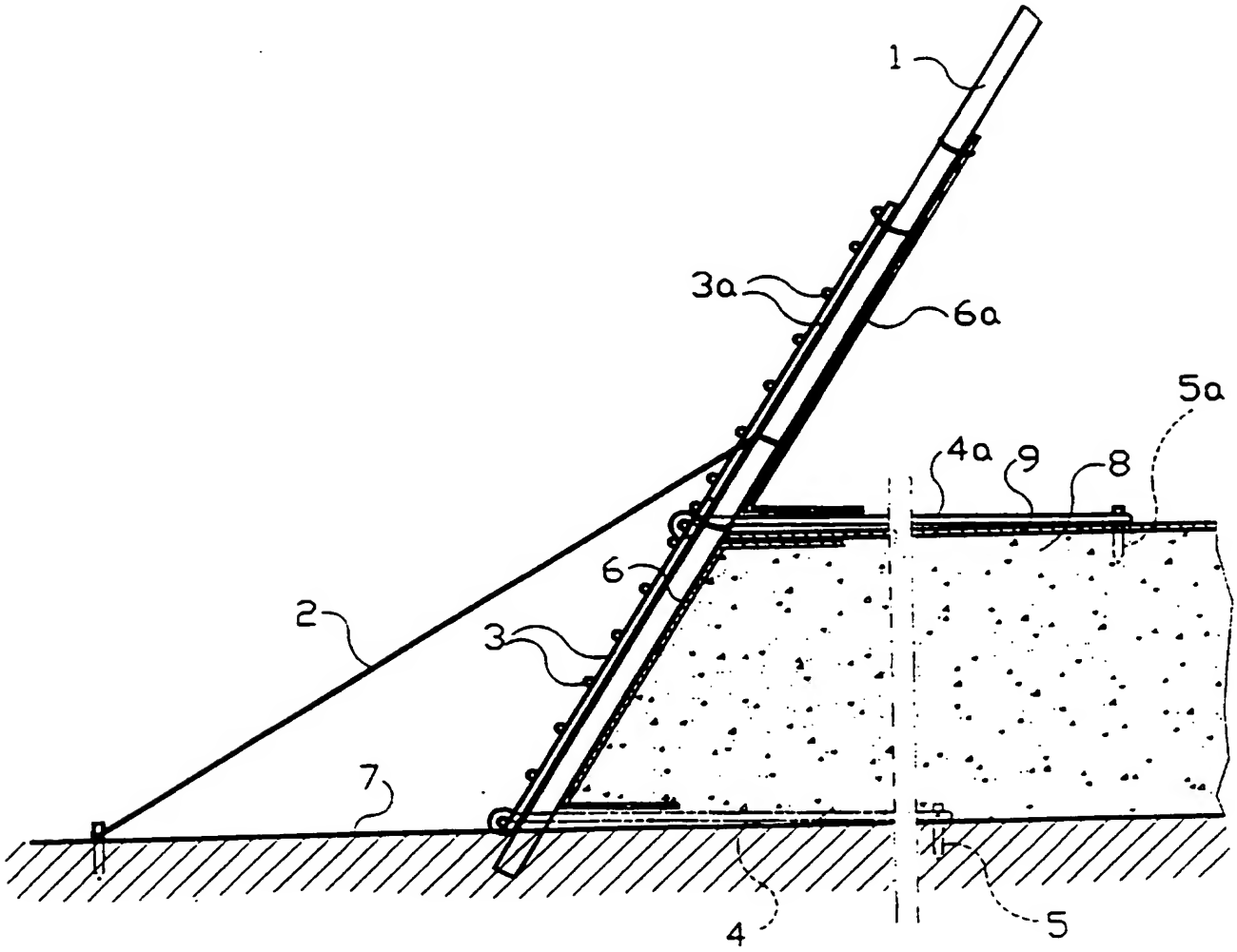
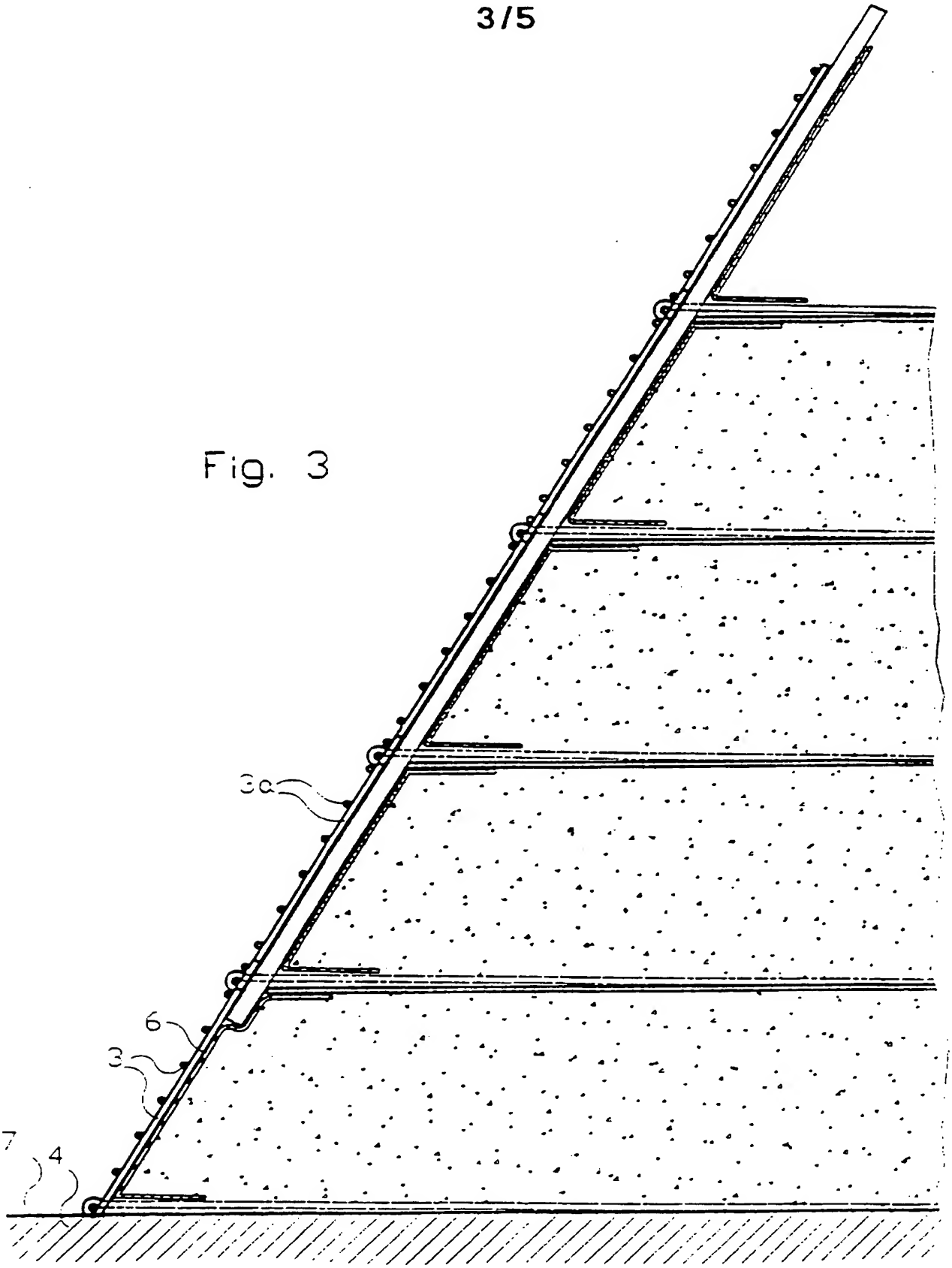


Fig. 2

Fig. 3



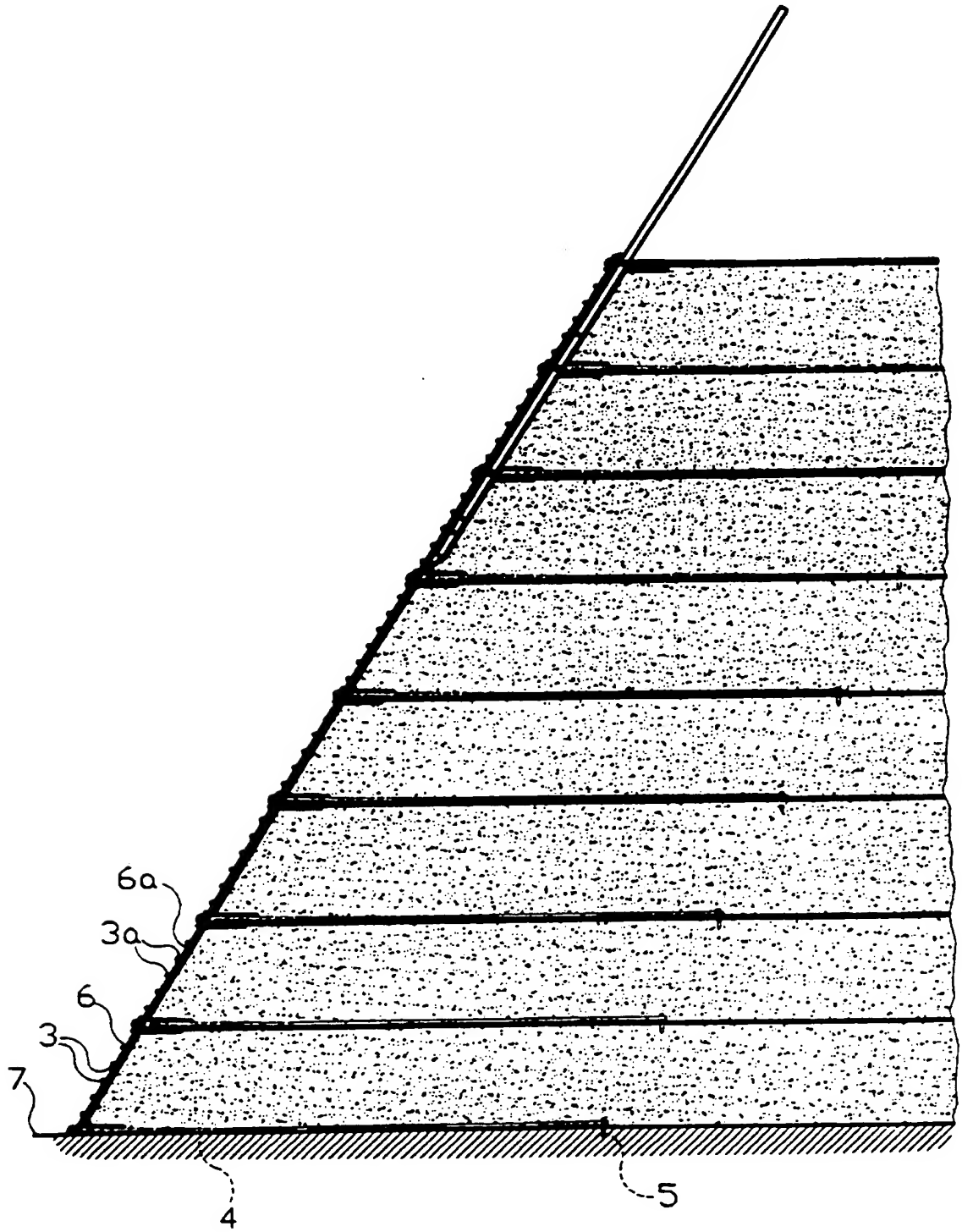


Fig. 4

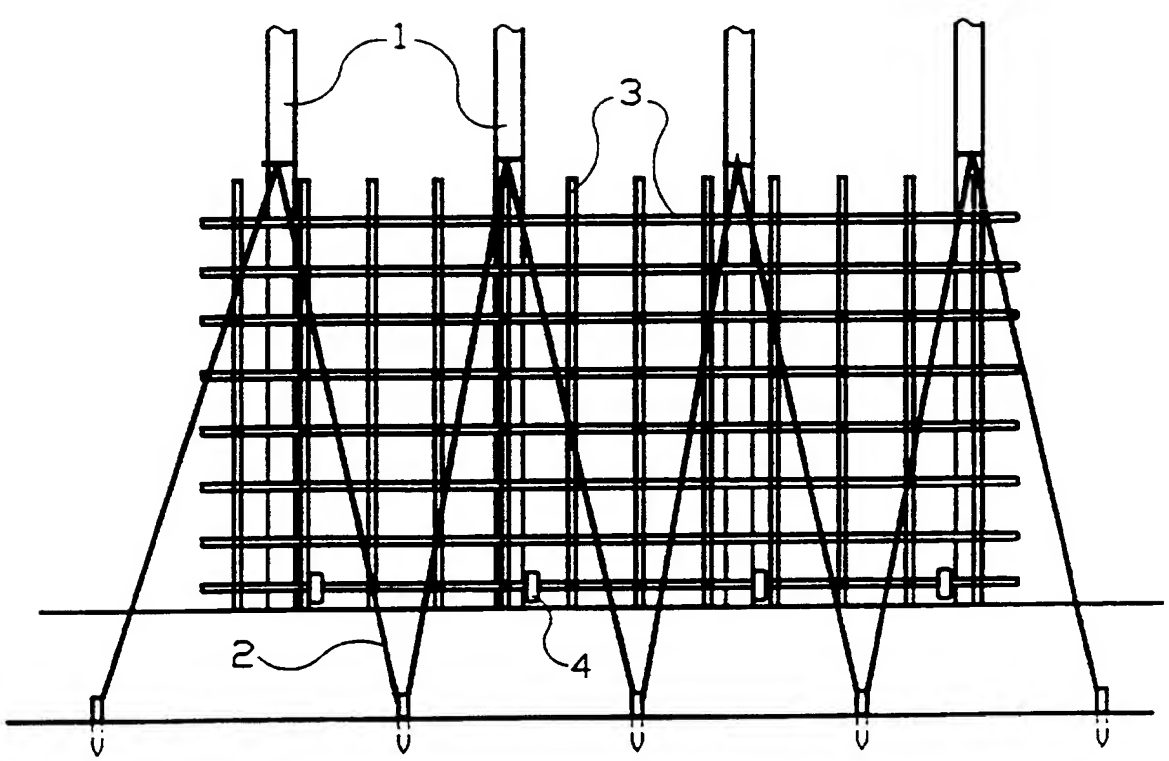


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 96/00087

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E02D 17/20, E02D 29/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E02D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0574233 A1 (GEA SYSTEM S.R.L), 15 December 1993 (15.12.93), figure 2, abstract ---	1
A	CH 680078 A5 (BOSSARD & STÄRKLE AG), 15 June 1992 (15.06.92), see whole document ---	1
A	CH 666510 A5 (FRITZ LANDOLT AKTIENGESELLSCHAFT), 29 July 1988 (29.07.88), description page 2, column 2, line 60 - line 67, figures 1,3a --- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

01/07/96

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A1- 0574233	15/12/93	NONE	
CH-A5- 680078	15/06/92	AT-A- 55392	15/09/95
		AT-B- 400964	28/05/96
		DE-A,A- 4208964	24/09/92
CH-A5- 666510	29/07/88	EP-A,A,B 0197000	08/10/86
		SE-T3- 0197000	